# Space Weather Technical Forecast

Issued on Saturday, 27 July 2024 at 13:24 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

**Space Weather Forecast Headline: G1-G2/Minor to Moderate Storms expected into Days 3 and 4 (29-30 Jul) given potential CME arrivals. Isolated R1-R2 Radio Blackouts likely throughout.**

## Analysis of Space Weather Activity over past 24 hours

**Solar Activity:** Solar activity has been Moderate, with the largest flare a M4.2 observed peaking at 27/0237 UTC from the complex in the southeast, likely near AR3766. A M3.1 flare was also observed from the AR3762 region at 27/0546UTC, with both the previously mentioned region contributing to a further M2.0 at 27/1040UTC. There are ten sunspot regions on the solar disc, with AR3768 and AR3769 recently numbered. AR3762 in the southwest quadrant remains the largest and most complex region with weak delta spots visible in the trailing portion. A cluster of sunspot regions is also transiting across the southeast quadrant, which have been growing in complexity as they transit across the disc although most spots seems largely stable in recent hours. All other remaining regions appear small, simple and/or largely unchanged.

The large partial HALO CME observed to the east early on the 27th has been assessed as far-sided. However subsequent dimming associated with the above mentioned M-flares indicates likely CME activity. Any CME associated with the first M4.2 flare remains under investigation but a HALO CME associated with the M3.1 flare has been assessed as likely Earth directed and we await modeling data.

**Solar Wind / Geomagnetic Activity:** Solar winds, as measured by ACE at L1, were initially elevated around 540km/s, steadily before declining to near 440 km/s. Density was well below average. The Interplanetary magnetic field, Bt, was at weak to moderate levels around 6-8nT. The north-south component, Bz, became weakly variable during the period. The phi angle was predominately positive (away from the Sun). Geomagnetic activity was generally Quiet to Unsettled (Kp 2-3), with Active (Kp4) intervals observed 26/1200-1500 UTC and 27/0900-1200 UTC.

**Energetic Particles / Solar Radiation:** High energy (greater than 10 MeV) proton flux observed by GOES18 is at background levels. High energy electron flux (greater than 2MeV) observed at GOES16 was at background levels. The 24-hour fluence was well below Active, with 9.63e5 integrated pfu observed at 27/0000UTC.

## Four-Day Space Weather Forecast Summary

**Solar Activity:** Activity is expected to be Low to Moderate with further M-class flares likely and slight chance of isolated X-class flares.

**Solar Wind /Geomagnetic Activity:** Confidence in a CME arriving early in the period is lowering, with the risk reducing as we move through the remainder of day 1 (27 Jul). A filament liftoff and associated CME from the southern centre disk was observed in coronagraph imagery late on the 26th. This feature analysed as Earth directed with an arrival into day 4 (30 Jul).

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Confidence in the timing of this feature is reduced however given further CME activity early on the 27th. A further HALO CME was observed associated with the M3.1 from AR3762, this is likely Earth directed and while we await modeling data initial assessment suggests an arrival sometime later on day 3 (29 Jul) with most likely some interaction with the previous filament CME. Overall, there is significant uncertainty in the forecast through this period with larger far-sided activity heavily contaminating imagery and reducing analysis confidence.

Current solar wind speeds are thought likely to gradually decline in the absence of CME influence over the next couple of days to remain at generally background to slightly elevated levels.

Geomagnetic activity is currently expected to be generally Quiet to Unsettled to start, with a slight chance of Active to G1/Minor storm intervals on day 1 if we see any CME influence. Into days 3 and 4 activity is expected to increase with G1-G2 Minor to Moderate storm intervals expected and a slight chance of G3-G4 Strong to Severe intervals given the potential for CME arrival as discussed above.

**Energetic Particles / Solar Radiation:** High energy proton flux is most likely to remain at background levels. However, there is a slight chance of exceeding the S1/Minor Storm threshold should any notable flares occur, most likely from AR3762 in the near term.

The high energy electron flux may show an increasing trend in the next few days. The associated 24-hour fluence is most likely to remain below the Active threshold (1e8 integrated pfu) but with a potential rising trend during the period.

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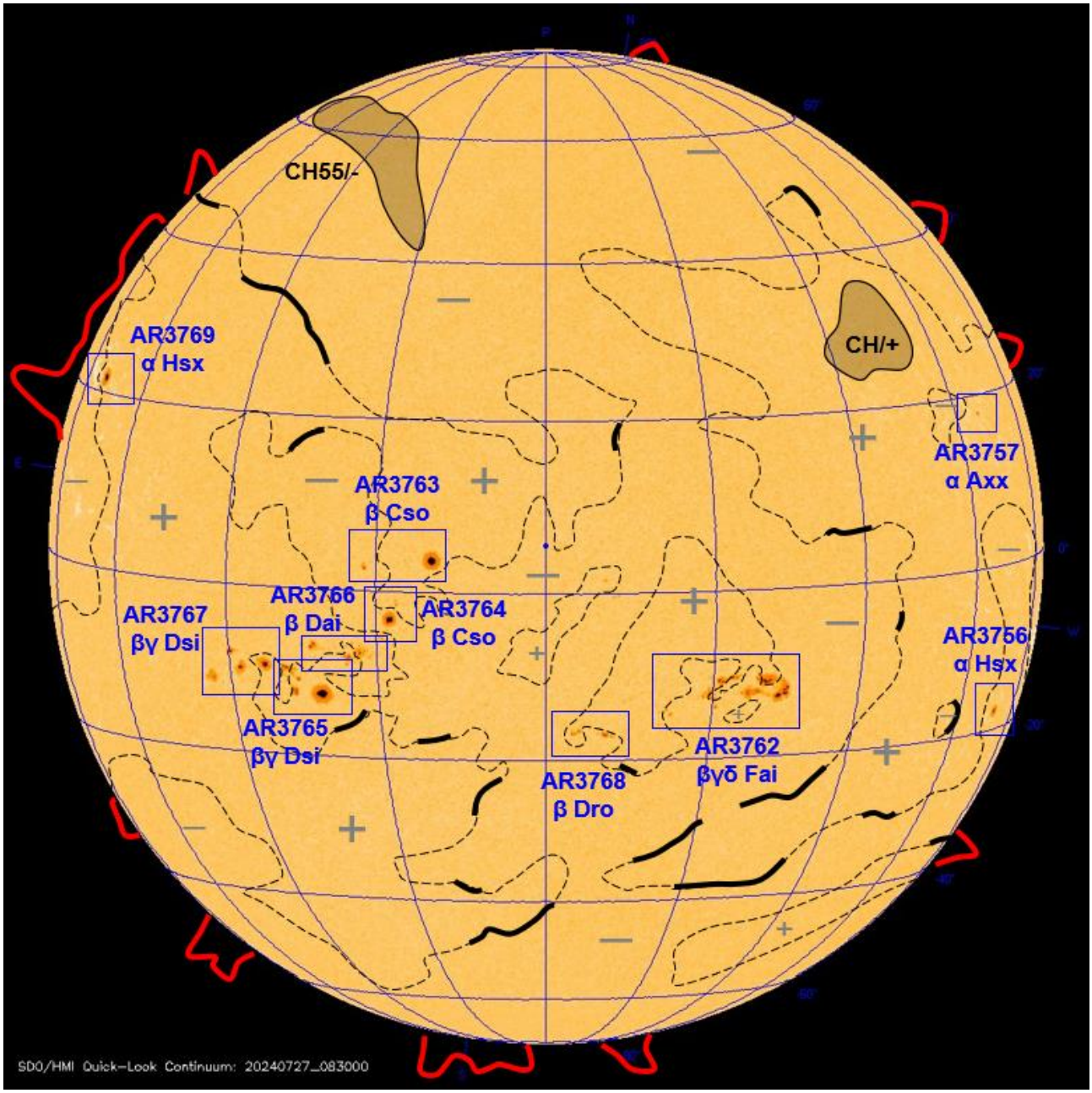
**Figure 1. Solar Analysis Valid 27/0800UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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# Met Office Space Weather Technical Forecast

## Geomagnetic Storms:

A long period M2.4 flare close to the southeast limb near AR3764 at 23/1430 UTC gave a wide and moderately fast CME, perhaps giving Earth a glancing blow early on Day 1 (27 Jul). Confidence in this feature arriving is lowering however, with the chance of any Earth directed influence reducing as we move through the remainder of day 1 (27 Jul). A filament liftoff and associated CME from the southern centre disk was observed in coronagraph imagery late on the 26th. This feature analysed as Earth directed with an arrival into day 4 (30 Jul). Confidence in the timing of this feature is reduced however given further CME activity early on the 27th. A further HALO CME was observed associated with the M3.1 from AR3762, this is likely Earth directed and while we await modeling data initial assessment suggests an arrival sometime later on day 3 (29 Jul) with most likely some interaction with the previous filament CME. Overall, there is significant uncertainty in the forecast through this period with larger far-sided activity heavily contaminating imagery and reducing analysis confidence.

Current solar wind speeds are thought likely to gradually decline in the absence of CME influence over the next couple of days to remain at generally background to slightly elevated levels, with no significant coronal hole features expected.

Geomagnetic activity is currently expected to be generally Quiet to Unsettled to start, with a slight chance of Active to G1/Minor storm intervals on day 1 if we see any CME influence. Into days 3 and 4 activity is expected to increase with G1-G2 Minor to Moderate storm intervals expected and a slight chance of G3-G4 Strong to Severe intervals given the potential for CME arrival as discussed above.

| Geo-Magnetic Storm | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability (Exceedance) | | | (%) | (%) | (%) | (%) |
| Minor or Moderate | G1 to G2 | No | 20 | 10 | 80 | 80 |
| Strong | G3 | No | 1 | 1 | 20 | 20 |
| Severe | G4 | No | 1 | 1 | 5 | 5 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time 21.5R (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed | Estimated Arrival Time | Comments |
|---|---|---|---|---|---|---|
| 27/0200 | Partial | Filament | South center disk | 600 km/s | 30/1100 UTC | Low confidence in timings |
| 27/1015 | Full | M3.1 flare | AR3762 | 873 km/s | 29/1800 UTC | Timings subject to change |

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**Radio Blackouts - X-Ray Flares:**
There are currently ten sunspot regions on the solar disc. AR3762 remains the largest and most complex region. It has now moved into the southwest quadrant and continues to display weak delta spots. A cluster of sunspot regions is also transiting across the southeast quadrant, which have been growing in size and complexity as they transit across the disc, bringing a rising flare risk. All other remaining regions appear small, simple and/or largely unchanged. Far-side sounding data and persistence suggest limited development rounding the east limb during the period, although by day 4 (30 Jul) there is the risk we may see the arrival of what appears to be an active region on the far-side, which may have been responsible for several larger far-sided flares in recent days.

Overall activity is expected to be Low to Moderate with further M-class flares likely and slight chance of isolated X-class flares.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | Yes | 60 | 60 | 60 | 60 |
| Very Active | R3 to R5 X Class | No | 10 | 10 | 10 | 10 |

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**Solar Radiation Storms - (High Energy Protons):**
High energy protons are currently at background levels. Proton flux is most likely to remain at background levels, although there is a slight chance of reaching the S1/minor radiation storm threshold if any notable flares occur from the west hemisphere of the disc. AR3762 is the most likely candidate to be the cause of any potential increase in proton flux but with an increasing risk component from the cluster of sunspots in the southeast into the period as they move west.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 10 | 10 | 15 | 15 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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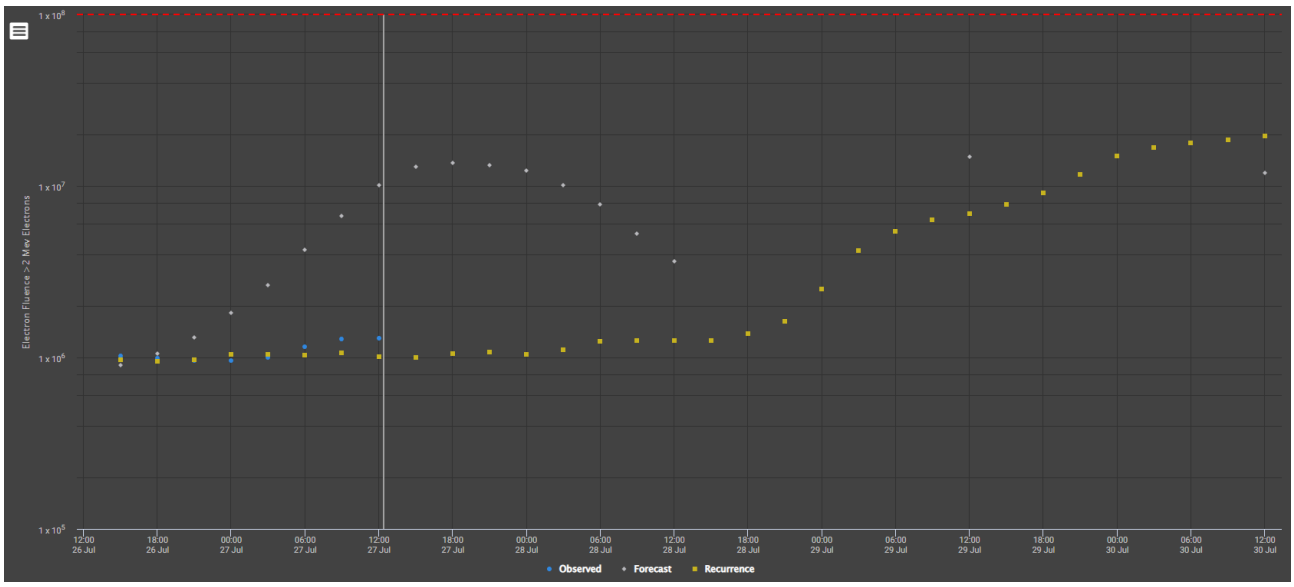
**High Energy Electrons Event (≥ 2MeV):**
High energy electron flux, as observed by GOES-16, is expected to remain at background levels for the start of the period. The recent CME and potential fast wind enhancement may have caused an increase in electron flux below GEO, but the potential for further CME arrivals into the period could suppress this once again. Overall, electron flux is most likely to stay at background levels, but as the solar wind speeds decline there is the possibility of an increase to peak at moderate or perhaps high levels at times.

The associated electron fluence is most likely to persist below the Active threshold (1e8 integrated pfu), but with the potential for a rising trend during the period. The latest MOSWOC REFM output is forecasting a rising trend below Active, which is viewed as generally good guidance though with lower than usual confidence given the potential for further CME influence.

| GEO Electron Environment<br>Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1x10^8$** | No | 1 | 5 | 10 | 20 |
| **Very Active** | **≥ 2 MeV ≥ $1x10^9$** | No | 1 | 1 | 1 | 1 |

**Figure 2: Latest MOSWOC REFM model output**

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